

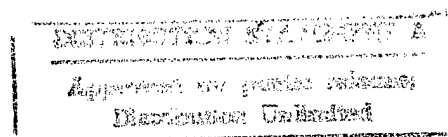


ENERGY CONSULTANTS  
HVAC SPECIALISTS

FINAL REPORT  
~~MARCH, 1991~~  
February 1992  
VOLUME I - EXECUTIVE SUMMARY

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)  
LAUNDRY PLANT STUDY  
FORT LEONARD WOOD, MISSOURI

DEPARTMENT OF THE ARMY  
U.S. ARMY CORPS OF ENGINEERS  
KANSAS CITY DISTRICT  
CONTRACT NO. DACA41-89-0-0007



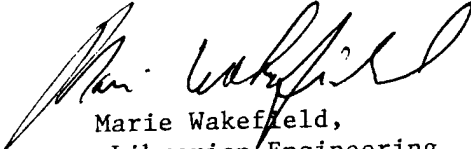


DEPARTMENT OF THE ARMY  
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS  
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Marie Wakefield,  
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## EXECUTIVE SUMMARY

### 1 INTRODUCTION

This report is the final submittal for work performed under Contract No. DACA41-89-C-0007 consisting of a Laundry Plant Study at Fort Leonard Wood, Missouri. This study is prepared as part of the Energy Engineering Analysis Program (EEAP).

This report is divided into 2 separately bound volumes:

#### VOLUME I

Title: Executive Summary

Contents: Complete Project Summary

#### VOLUME II

Title: Laundry Plant Study - Final Report

Contents: Project Overview, Energy Audit, ECO Descriptions & Summary, ECO Calculations & Economic Analysis, Programming Documents, and report appendices.

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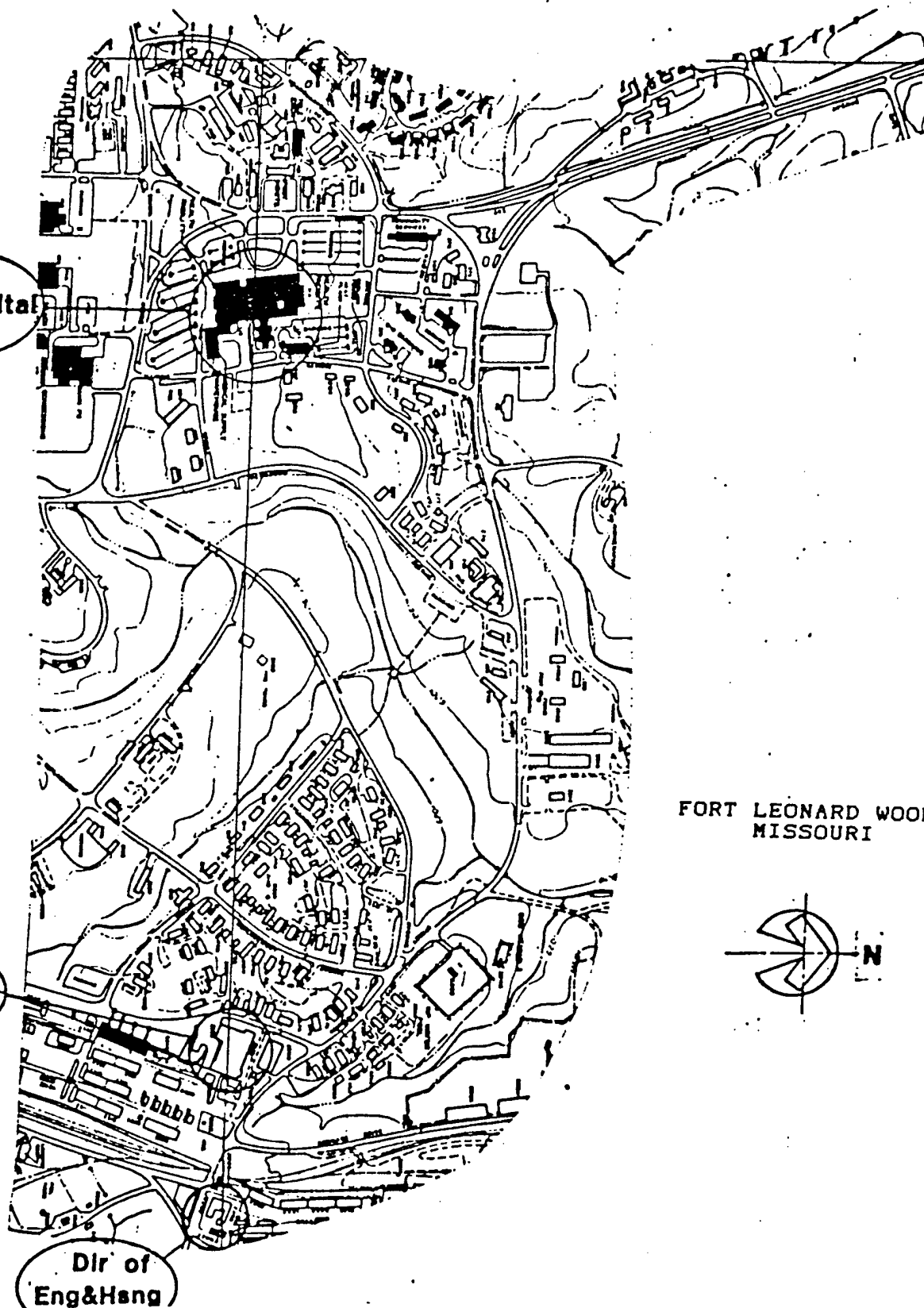
## 11 FACILITY DESCRIPTION

The Fort Leonard Wood Laundry Plant is located in Building 2352 which is situated in the Northeast portion of Main Post. Building 2352 has approximately 48,000 square feet of floor space which contains various types of laundry and dry cleaning process equipment. The facility provides service to the Post Hospital and Army training units. The facility also provides service to individuals on a piece rate basis.

Building 2352 is heated with steam unit heaters. The building has no cooling except for window air conditioners serving the accounting area. The plant area has ventilation fans to provide air circulation during the cooling season.

The laundry plant receives steam and hot water from the Boiler Plant located Building 2351. The steam is used for building heating and for process requirements of the laundry equipment. The hot water is used by the laundry plant's washing machines.

In addition to the steam and hot water supplied from the boiler plant, the laundry facility also has some gas-fired dryers which use LPG as a source of heating energy.



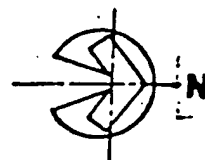
To  
Main -  
Gate

Main Hospital

Bldg 2352

Dir of  
Eng&Hang

FORT LEONARD WOOD  
MISSOURI



[illegible]

### 111 EXISTING ENERGY CONSUMPTION

An analysis of utility bills for fiscal years 1985 through 1987 shows that approximately \$194,600 is spent each year to purchase energy to operate the laundry facility. Of that amount approximately \$33,400 is spent on electricity; \$138,500 is spent on purchase of liquid petroleum gas (LPG); and the remaining \$22,700 is used to purchase #2 fuel oil.

Table III-1 displays information extracted from utility records for the laundry facility. Fuel consumption is based upon meter readings taken at the boiler plant located in Building 2351. Energy costs are based upon actual expenditures made to fuel suppliers. As shown, total fuel consumption was highest in FY 85 with total fuel use at 34,215 million btu. Total fuel use in FY 86 & FY 87 was approximately 14% lower with total fuel use at 29,356 and 29,522 million BTU respectively. Total electricity consumption is listed as 2337, 2472, and 2417 million BTU for FY 85, 86 & 87.

Table III-2 shows average monthly energy use over the three year period between FY 85 and FY 87. Annual electricity use averages to 705,723 KWH or 2408 million BTU. Propane consumption averages to 286,409 gallons per year which equates to an energy use of 27,352 million BTU. Average fuel oil consumption is shown as 26,539 gallons which equates to 3679 million BTU of energy. Total average fuel use equates to 31,031 million BTU.

Figures III-1, III-2 & III-3 graphically depict the information contained in Table III-2.

Fuel oil is used on a random and infrequent basis at the boiler plant in Building 2351. Over a three year period the consumption of fuel oil consists of less than 12% of total fuel use. Since fuel oil usage makes up such a small percentage of total use, calculations and life cycle cost analysis contained in this report consider LPG as the only fuel used at the Laundry Facility. Therefore, fuel saving resulting from ECO's are considered as savings in LPG.

Not reflected in utility data is water usage. Water is a valuable resource and considerable dollar savings are possible through a reduction in consumption of domestic water. However, water is not considered as an energy resource, and a detailed analysis of water consumption is outside the scope of work of this study. For example, the cost associated with supplying water to Fort Leonard Wood facilities is approximately 68 cents per 1000 gallons of water. ECO #20 saves approximately 1,735,500 gallons of water each year which amounts to a dollar savings of \$1180.00.

TABLE III-1  
BUILDING 2352 - FORT LEONARD WOOD, MO.  
UTILITY DATA FY 85 -FY 87

YEAR		KWH	ELEC MBTU'S	ELEC \$	LPG GALS	LPG MBTU'S	LPG \$	#2 FUEL GALS	#2 FUEL MBTU'S	#2 FUEL \$	TOTAL \$
OCT	84	55754	190	2648.00	28509	2723	15247.00	350	49	340.00	18235.00
NOV	84	52680	180	2502.00	34882	3331	18655.00	440	61	427.00	21584.00
DEC	84	38790	132	1843.00	27374	2614	14640.00	1236	171	1200.00	17683.00
JAN	85	43042	147	2045.00	44290	4230	23686.00	364	50	353.00	26084.00
FEB	85	86292	295	4099.00	33613	3210	17976.00	1343	186	1304.00	23379.00
MAR	85	47656	163	2264.00	23790	2272	12723.00	2640	366	2563.00	17550.00
APR	85	50700	173	2408.00	32329	3087	17290.00	1760	244	1790.00	21488.00
MAY	85	65818	225	3126.00	20468	1955	10946.00	1467	203	1424.00	15496.00
JUN	85	44496	152	2114.00	22833	2181	12211.00	1222	169	1187.00	15512.00
JUL	85	65278	223	3101.00	19215	1835	10276.00	1497	208	1454.00	14831.00
AUG	85	73040	249	3572.00	27735	2649	14833.00	2365	328	2296.00	20701.00
SEP	85	61042	208	2985.00	19308	1844	10326.00	1796	249	1744.00	15055.00
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TOTAL		684588	2337	32707.00	334346	31931	178809.00	16480	2284	16082.00	227598.00

YEAR		KWH	ELEC MBTU'S	ELEC \$	LPG GALS	LPG MBTU'S	LPG \$	#2 FUEL GALS	#2 FUEL MBTU'S	#2 FUEL \$	TOTAL \$
OCT	85	59646	204	2917.00	40742	3891	21789.00	1145	159	973.00	25679.00
NOV	85	52150	178	2467.00	28587	2730	13307.00	1131	157	961.00	16735.00
DEC	85	76254	260	3607.00	32199	3075	14989.00	2677	371	2275.00	20871.00
JAN	86	74462	254	3522.00	21994	2100	10238.00	5238	726	4451.00	18211.00
FEB	86	37292	127	1764.00	16980	1622	7904.00	2262	314	1922.00	11590.00
MAR	86	75970	259	3593.00	22390	2138	10423.00	2335	324	1984.00	16000.00
APR	86	64484	220	3050.00	19619	1874	9133.00	1362	189	1157.00	13340.00
MAY	86	37400	128	1769.00	17208	1643	8010.00	1255	174	1066.00	10845.00
JUN	86	67704	231	3202.00	17594	1680	8190.00	1326	184	1127.00	12519.00
JUL	86	64850	221	3067.00	18738	1789	8723.00	1085	150	922.00	12712.00
AUG	86	48534	166	2233.00	12821	1224	5968.00	1788	247	1511.00	9712.00
SEP	86	65500	224	3013.00	10630	1015	4948.00	11392	1580	9681.00	17642.00
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		724246	2472	34204.00	259502	24781	123622.00	32996	4575	28030.00	185856.00

YEAR		KWH	ELEC MBTU'S	ELEC \$	LPG GALS	LPG MBTU'S	LPG \$	#2 FUEL GALS	#2 FUEL MBTU'S	#2 FUEL \$	TOTAL \$
OCT	86	53466	182	2459.00	17041	1627	7933.00	6868	953	5424.00	15816.00
NOV	86	53712	183	2471.00	27674	2643	12882.00	1244	173	983.00	16336.00
DEC	86	75030	256	3451.00	28691	2740	12019.00	2825	392	2231.00	17701.00
JAN	87	69998	239	3220.00	30622	2924	12828.00	5186	719	4096.00	20144.00
FEB	87	45284	155	2160.00	27398	2617	11477.00	3277	454	2588.00	16225.00
MAR	87	61600	210	2944.00	23431	2238	9815.00	4380	607	3459.00	16218.00
APR	87	64780	221	3096.00	19976	1908	8368.00	2857	396	2256.00	13720.00
MAY	87	52750	180	2521.00	16988	1622	7116.00	1496	207	1182.00	10819.00
JUN	87	64016	218	3060.00	18036	1722	7555.00	412	57	325.00	10940.00
JUL	87	78666	268	3760.00	15230	1454	6380.00	448	62	354.00	10494.00
AUG	87	33276	114	1591.00	20178	1927	8453.00	404	56	319.00	10363.00
SEP	87	55758	190	2665.00	20113	1921	8425.00	744	103	588.00	11678.00
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		708336	2416	33398.00	265378	25343	113251.00	30141	4179	23805.00	170454.00



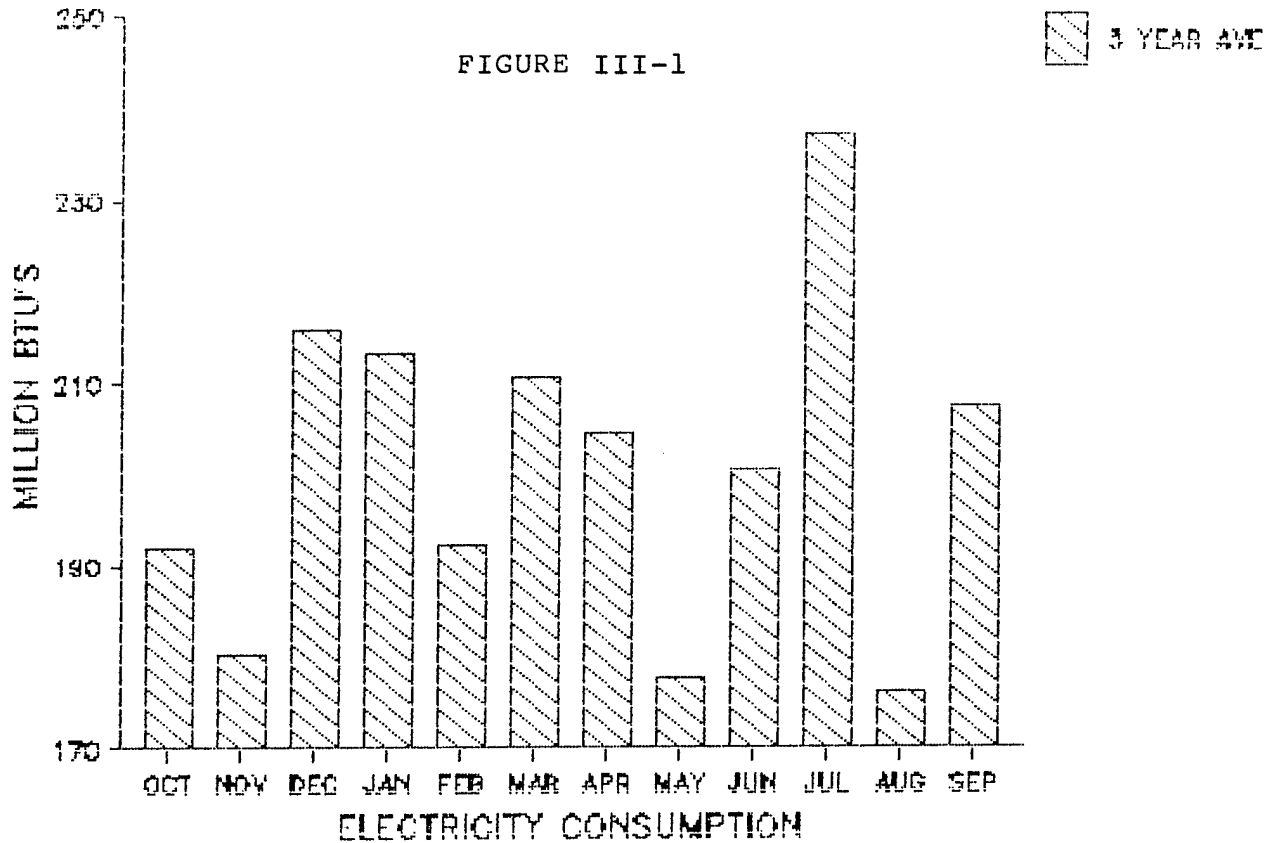
TABLE III-2  
BUILDING 2352 - FORT LEONARD WOOD, MO.  
UTILITY DATA FY 85 -FY 87

YEAR		KWH	ELEC MBTU'S	ELEC \$	LPG GALS	LPG MBTU'S	LPG \$	#2 FUEL GALS	#2 FUEL MBTU'S	#2 FUEL \$	TOTAL \$
OCT	AVE	56289	192	2674.67	28764	2747	14989.67	2788	387	2245.67	19910.00
NOV	AVE	52847	180	2480.00	30381	2901	14948.00	938	130	790.33	18218.33
DEC	AVE	63358	216	2967.00	29421	2810	13882.67	2246	311	1902.00	18751.67
JAN	AVE	62501	213	2929.00	32302	3085	15584.00	3596	498	2966.67	21479.67
FEB	AVE	56289	192	2674.33	25997	2483	12452.33	2294	318	1938.00	17064.67
MAR	AVE	61742	211	2933.67	23204	2216	10987.00	3118	432	2668.67	16589.33
APR	AVE	59988	205	2851.33	23975	2290	11597.00	1993	276	1734.33	16182.67
MAY	AVE	51989	178	2472.00	18221	1740	8690.67	1406	195	1224.00	12386.67
JUN	AVE	58739	200	2792.00	19488	1861	9318.67	987	137	879.67	12990.33
JUL	AVE	69598	237	3309.33	17728	1693	8459.67	1010	140	910.00	12679.00
AUG	AVE	51617	176	2465.33	20245	1933	9751.33	1519	210	1375.33	13592.00
SEP	AVE	60767	207	2887.67	16684	1593	7899.67	4644	644	4004.33	14791.67
TOTAL		705723	2408	33436.33	286409	27352	138560.67	26539	3679	22639.00	194636.00

YEAR		\$ PER KWH	\$ PER MBTU'S	ELEC \$	\$ PER GAL LPG	\$ PER MBTU'S	LPG \$	\$ PER GAL #2	\$ PER MBTU'S	#2 FUEL \$	TOTAL \$
OCT	AVE	.0475170	13.931	2674.67	.52112594	5.456741	14989.67	.8055722	5.802756	2245.67	19910.00
NOV	AVE	.0469276	13.752	2480.00	.49201804	5.152114	14948.00	.8422735	6.063939	790.33	18218.33
DEC	AVE	.0468291	13.736	2967.00	.47185716	4.941037	13882.67	.8468388	6.109208	1902.00	18751.67
JAN	AVE	.0468635	13.730	2929.00	.48244691	5.052086	15584.00	.8249907	5.953177	2966.67	21479.67
FEB	AVE	.0475105	13.905	2674.33	.47899117	5.015036	12452.33	.8448126	6.094340	1938.00	17064.67
MAR	AVE	.0475149	13.926	2933.67	.47350275	4.958032	10987.00	.8557990	6.172706	2668.67	16589.33
APR	AVE	.0475317	13.932	2851.33	.48371893	5.064929	11597.00	.8702124	6.276236	1734.33	16182.67
MAY	AVE	.0475482	13.914	2472.00	.47695010	4.994636	8690.67	.8705548	6.287671	1224.00	12386.67
JUN	AVE	.0475326	13.937	2792.00	.47818278	5.007344	9318.67	.8915541	6.436585	879.67	12990.33
JUL	AVE	.0475493	13.944	3309.33	.47720136	4.997834	8459.67	.9009901	6.5	910.00	12679.00
AUG	AVE	.0477624	13.981	2465.33	.48167419	5.043793	9751.33	.9054202	6.538827	1375.33	13592.00
SEP	AVE	.0475206	13.928	2887.67	.47349703	4.957950	7899.67	.8622595	6.217909	4004.33	14791.67
12 MONTH		.0473839	13.884	2786.36	.48259720	5.053461	11546.72	.8601065	6.204446	1886.58	16219.67

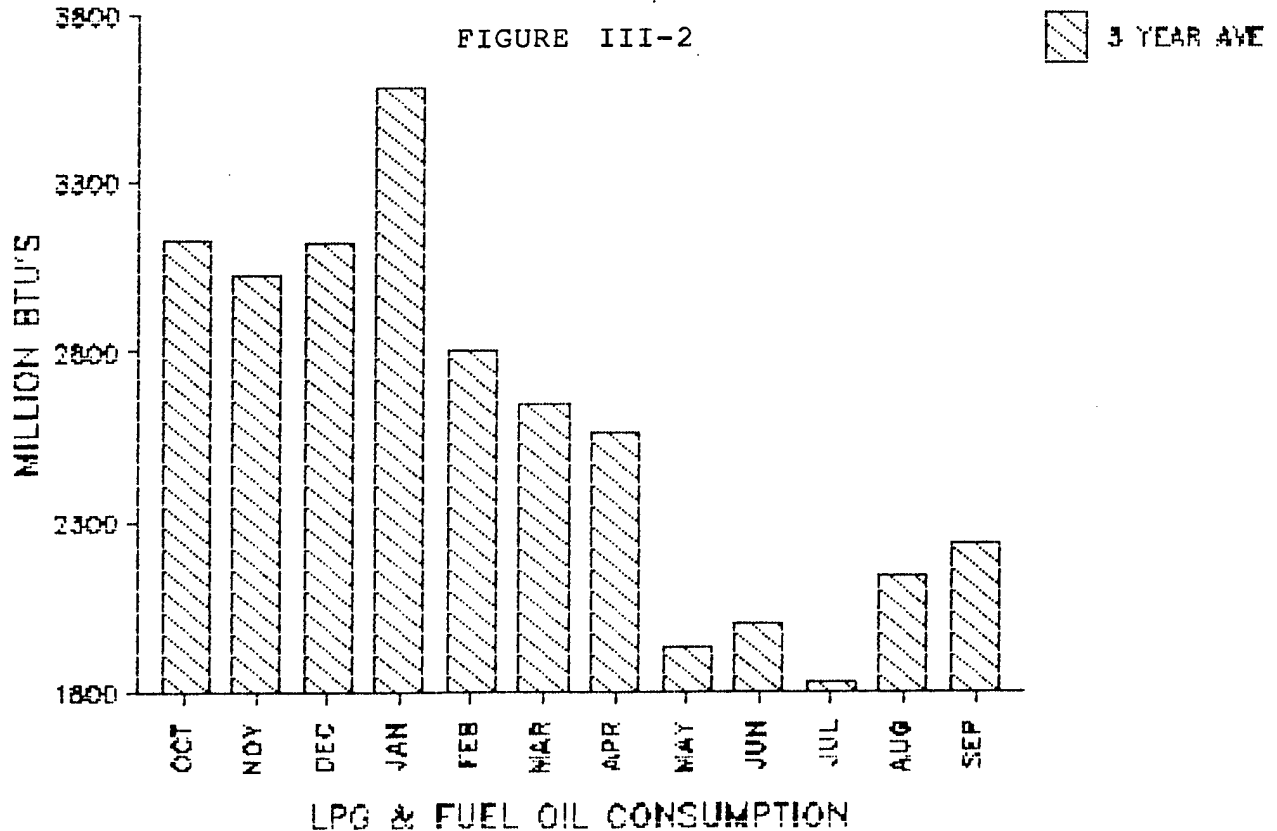
# BLDG 2352 - FT. WOOD, MO.

TOTAL USE - 2408 MIL. BTU'S



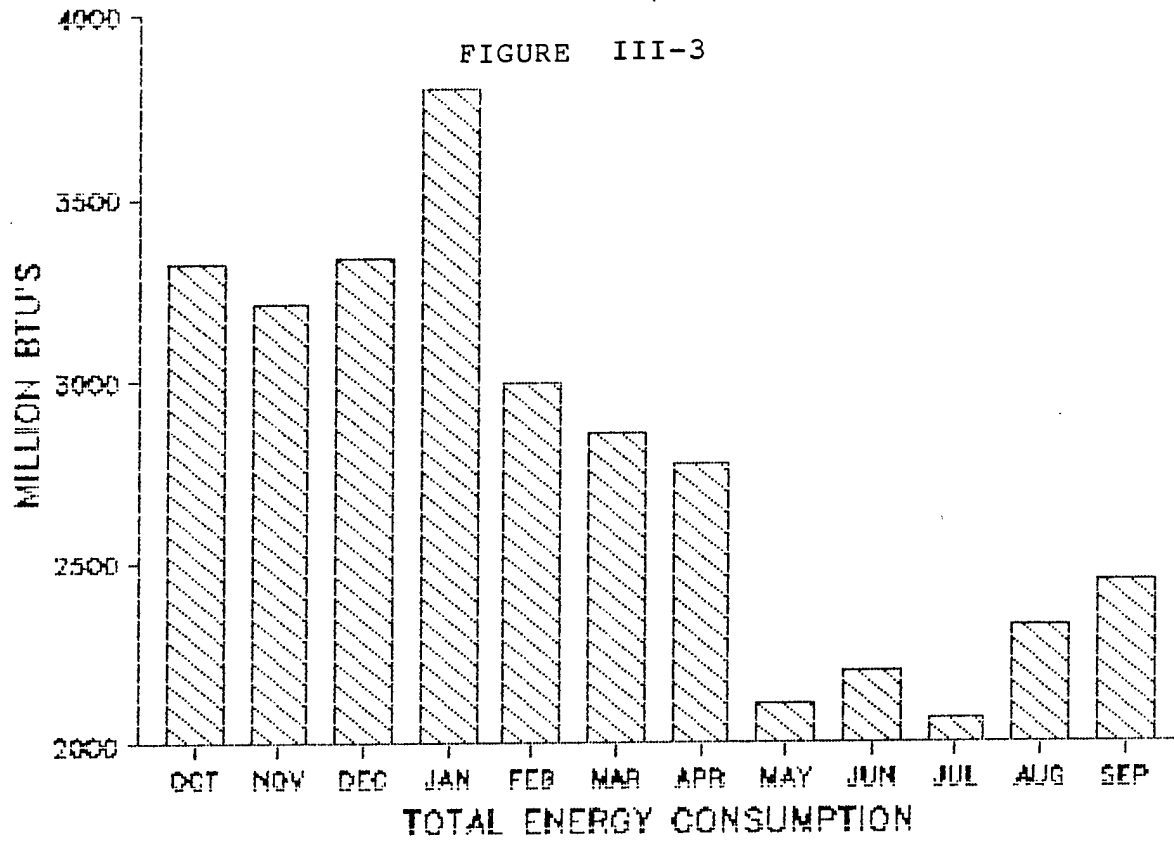
# BLDG 2352 - FT. WOOD, MO.

TOTAL USE - 31,031 MIL. BTU'S



BLDG 2352 — FT. WOOD, MO.

TOTAL USE — 33,439 MIL. BTU'S



#### IV PURPOSE & SCOPE OF STUDY

##### A. PURPOSE

The purpose of this energy engineering analysis program (EEAP), Laundry Plant Study at Ft. Leonard Wood, Missouri is to develop energy saving type projects for funding through the energy conservation investment program (ECIP) or other applicable funding source.

##### B. SCOPE OF WORK

The following outlines the tasks performed in this study. The complete scope of work is included in Appendix G of this report.

1. Review of previously completed energy engineering analysis program (EEAP) studies applicable to the laundry facilities.
2. Perform a detailed survey of the laundry facility and associated energy using equipment.
3. Perform a complete energy audit and analysis of the laundry facilities.
4. Identify energy conservation opportunities including low cost/no cost items.
5. Provide complete programming and implementation documentation for all recommended ECO's.
6. Prepare a comprehensive report documenting the work accomplished and the results of the study.

Contract Annex A, ENERGY CONSERVATION OPPORTUNITIES, provides a minimum list of ECO's to be evaluated under this contract. A copy of Annex A follows:

ANNEX A  
ENERGY CONSERVATION OPPORTUNITIES  
LAUNDRY STUDY  
FORT LEONARD WOOD, MISSOURI

1. Insulation (wall, roof, pipe, duct, etc.)
2. Insulated glass or double glazed windows
3. Weather stripping & caulking
4. Solar films
5. Vestibules
6. Reduction of glass area
7. Shutdown energy to hot water heaters or modify controls
8. Energy conserving fluorescent lamps and ballasts
9. Reduce lighting levels
10. Replace incandescent lighting
11. Use more efficient lighting source
12. Infrared heaters
13. Heat reclaim from laundry equipment
14. Heat destratification
15. Heat recovery from laundry wash water
16. Booster heaters at major hot water users
17. Lower processing hot water temperature
18. Make HVAC operations more efficient
19. Steam traps (size, operation, type)
20. Optimize laundry facilities operation (space utilization, more efficient equipment-operational procedures)

21. Use air curtains/plastic strips at personnel entrances
22. Dryers equipped with temperature sensor located on discharge duct. Sensor to provide information to stop heating during drying cycle at the most energy efficient point.
23. Recycling of rinse water for a following wash cycle
24. Equipping dryer exhaust with heat exchanger for preheating incoming air to dryer
25. Verify that supply steam and condensate system is functioning in the most efficient manner
26. Utilization of high temperature, oil heated processes rather than steam
27. Use of cold water laundering
28. Waste heat recovery
29. Efficiency of compressed air system
30. Thermal storage
31. Shut off steam supply during non use hours

## V ENERGY CONSERVATION OPPORTUNITIES NOT ANALYZED

Of the 31 ECO's listed in Contract Annex A, 15 were eliminated from consideration prior to any calculation of potential energy saving.

- \* ECO #2 - identifies insulated glass or double glazed windows as an ECO. All windows have been replaced in a recent building renovation and are double glazed. Therefore this item was not evaluated.
- \* ECO #4 - identifies solar films as an ECO. The building is not air conditioned and therefore solar films were not evaluated.
- \* ECO #5 - identifies vestibules as an ECO. Vestibules are in place at existing primary entrances and therefore were not evaluated.
- \* ECO's #9, #10 & #11 - identify conservation opportunities as related to building lighting. The facility has only one incandescent fixture and the remaining lighting consists of standard suspended fluorescent fixtures. Therefore, all potential conservation measures related to building lighting are addressed in ECO #8 titled "Lighting Modifications".
- \* ECO #13 - identifies heat reclaim from laundry equipment. The laundry washers and dryers represent the process equipment most likely to benefit from heat reclaim. Heat reclaim for washers is addressed in ECO's 15 and 15A. Heat reclaim for dryers is addressed in ECO's 24 and 24A.
- \* ECO #16 - identifies the use of booster heaters for major hot water users. Booster heaters are all ready in place at the laundry facility.
- \* ECO #18 - addresses improved efficiency for HVAC systems. The laundry facility generates a great deal of heat from process equipment and therefore the building heating system is relatively small and simplistic. The facility is not air conditioned. Due to the nature of the existing HVAC systems, there is little potential for conservation in this area.
- \* ECO #22 - addresses conservation of energy by using sensors in dryer discharges ducts to control drying cycles. This feature exists in those dryers used in ECO's 20A and 20B.
- \* ECO #25 (steam & condensate efficiency) - the existing steam and condensate system is functioning efficiently and this ECO was not evaluated.
- \* ECO #28 (waste heat recovery) - this ECO is evaluated as part of ECO's 15, 15A, 24 & 24A.

- \* ECO #29 (efficiency of the compressed air system) - a new air compressor was being installed during the energy audit site survey. It is not feasible to replace the new air compressor and the piping is in good condition with no apparent leaks, therefore no ECO's were evaluated for the compressed air system.
- \* ECO #30 (thermal storage) - thermal storage is a feature of the packaged equipment used in ECO's 15 and 15A. Further use of thermal storage was not considered.



## VI ENERGY CONSERVATION OPPORTUNITIES ANALYZED

Of the 31 ECO's listed in the Contract Annex, 16 were analyzed for potential energy savings. In some cases an ECO was considered with different options. In that case a letter suffix was attached to the ECO number to identify each option separately. The total number of ECO's analyzed including options is 21. Some ECO's have been re-titled to give a more accurate description of the type modification required to achieve energy savings. A list of all ECO's considered in this report follows:

<u>ECO #</u>	<u>ECO TITLE</u>
1	Repair Pipe Insulation
3	Caulk & Seal Windows
6	Reduce Window Area
7	Install Gas Fired Hot Water Heater
8	Lighting Modifications
12	Install Radiant Heaters
14	Heat Destratification
15	Install Wash Water Heat Recovery Unit
15A	Install Wash Water Heat Recovery Unit With New Heater
17	Lower Hot Water Supply Temperature
19	Replace Steam Traps
20	Install 1000 LB Continuous Batch Washer
20A	Replace Steam Dryers
20B	Replace 400 LB Gas Dryer
21	Install Air Curtain
23	Recycle Rinse Water

- 24            Install Exhaust Heat Recovery on 100 LB Dryers
- 24A          Install Exhaust Heat Recovery on 400 LB Dryers
- 26            Install Thermal Fluid Presses
- 27            Cold Water Laundering
- 31            Turn Off Steam

## VII ENERGY CONSERVATION OPPORTUNITY (ECO) SUMMARY AND DESCRIPTION

Tables VII-1 & VII-2 show all of the energy conservation opportunities (ECO's) selected for analysis at the Fort Leonard Wood laundry facility. Table VII-1 lists ECO's in ascending numerical order. Table VII-2 lists ECO's in descending order of savings investment ratios.

The pages immediately following Table VII-2 contain a brief description of each ECO selected for analysis.

TABLE VII-1

ENERGY CONSERVATION OPPORTUNITY SUMMARY  
BUILDING 2352 - FORT LEONARD WOOD, MO.

ECO #	TITLE	FUEL SAVINGS (COST) MBTU	ELEC SAVINGS (COST) MBTU	FUEL SAVINGS (COST) \$	ELEC SAVINGS (COST) \$	TOTAL SAVINGS (COST) \$	INSTALLED COST	SIMPLE PAYBACK YEARS	SAVINGS INVESTMENT RATIO (SIR)
1	REPAIR PIPE INSULATION	901	0	2948.34	.00	2948.34	17531	5.95	1.95
3	CAULK & SEAL WINDOWS	298	0	975.15	.00	975.15	4814	4.94	1.37
6	REDUCE WINDOW AREA	-1.7	-.3	-5.56	-3.89	-9.45	1	-.11	-148.00
7	INSTALL GAS HW HEATER	702.9	0	2300.10	.00	2300.10	24702	10.74	1.50
8	LIGHTING MODIFICATIONS	0	54.23	.00	703.36	703.36	7975	11.34	.77
12	INSTALL RADIANT HEATERS	359.7	7.9	1177.05	102.46	1279.51	13754	10.75	1.06
14	HEAT DESTRATIFICATION	382	-208	1250.02	-2697.76	-1447.74	5646	-3.90	-.76
15	WASH WATER HEAT RECOVERY	4375	0	14316.31	.00	14316.31	120403	8.41	1.87
15A	WASH WATER HR WTH NEW HTR	3954	0	12938.67	.00	12938.67	110474	8.54	1.84
17	LOWER HW SUPPLY TEMP	941	0	3079.23	.00	3079.23	119	.04	418.31
19	STEAM TRAP REPLACEMENT	172	0	562.84	.00	562.84	105	.19	54.03
20	INSTALL 1000 LB CBW	2114.7	0	6919.93	.00	6919.93	103847	15.01	1.08
20A	REPLACE STEAM DRYERS	3123	2.8	10219.39	36.32	10255.71	84545	8.24	1.96
20B	REPLACE 400 LB DRYER	638.8	28.5	2090.35	369.65	2459.99	51605	20.98	.73
21	INSTALL AIR CURTAIN	393	0	1286.01	.00	1286.01	794	.62	10.92
23	RECYCLE RINSE WATER	2479	0	8112.03	.00	8112.03	32704	4.03	3.82
24	EXHAUST HR 100 LB DRYERS	7678	-153	25124.72	-1984.41	23140.31	379122	16.38	1.00
24A	EXHAUST HR 400 LB DRYERS	1273	0	4165.64	.00	4165.64	57927	13.91	1.16
26	THERMAL FLUID PRESSES	1620	13.75	5301.13	178.34	5479.46	220006	40.15	.42
27	COLD WATER LAUNDERING	2098	-20	6865.29	-259.40	6605.89	119	.02	908.26
31	TURN OFF STEAM	1147	0	3753.33	.00	3753.33	8910	2.37	6.80

TABLE VII-2

ENERGY CONSERVATION OPPORTUNITY SUMMARY  
BUILDING 2352 - FORT LEONARD WOOD, MO.

ECO #	TITLE	FUEL SAVINGS (COST) MBTU	ELEC SAVINGS (COST) MBTU	FUEL SAVINGS (COST) \$	ELEC SAVINGS (COST) \$	TOTAL SAVINGS (COST) \$	INSTALLED COST	SIMPLE PAYBACK YEARS	SAVINGS INVESTMENT RATIO (SIR)
27	COLD WATER LAUNDERING	2098	-20	6865.29	-259.40	6605.89	119	.02	908.26
17	LOWER HW SUPPLY TEMP	941	0	3079.23	.00	3079.23	119	.04	418.31
19	STEAM TRAP REPLACEMENT	172	0	562.84	.00	562.84	105	.19	54.03
21	INSTALL AIR CURTAIN	393	0	1286.01	.00	1286.01	794	.62	10.92
31	TURN OFF STEAM	1147	0	3753.33	.00	3753.33	8910	2.37	6.80
23	RECYCLE RINSE WATER	2479	0	8112.03	.00	8112.03	32704	4.03	3.82
20A	REPLACE STEAM DRYERS	3123	2.8	10219.39	36.32	10255.71	84545	8.24	1.96
1	REPAIR PIPE INSULATION	901	0	2948.34	.00	2948.34	17531	5.95	1.95
15	WASH WATER HEAT RECOVERY	4375	0	14316.31	.00	14316.31	120403	8.41	1.87
15A	WASH WATER HR WTH NEW HTR	3954	0	12938.67	.00	12938.67	110474	8.54	1.84
7	INSTALL GAS HW HEATER	702.9	0	2300.10	.00	2300.10	24702	10.74	1.50
3	CAULK & SEAL WINDOWS	298	0	975.15	.00	975.15	4814	4.94	1.37
24A	EXHAUST HR 400 LB DRYERS	1273	0	4165.64	.00	4165.64	57927	13.91	1.16
20	INSTALL 1000 LB CBW	2114.7	0	6919.93	.00	6919.93	103847	15.01	1.08
12	INSTALL RADIANT HEATERS	359.7	7.9	1177.05	102.46	1279.51	13754	10.75	1.06
24	EXHAUST HR 100 LB DRYERS	7678	-153	25124.72	-1984.41	23140.31	379122	16.38	1.00
8	LIGHTING MODIFICATIONS	0	54.23	.00	703.36	703.36	7975	11.34	.77
20B	REPLACE 400 LB DRYER	638.8	28.5	2090.35	369.65	2459.99	51605	20.98	.73
26	THERMAL FLUID PRESSES	1620	13.75	5301.13	178.34	5479.46	220006	40.15	.42
14	HEAT DESTRATIFICATION	382	-208	1250.02	-2697.76	-1447.74	5646	-3.90	-.76
6	REDUCE WINDOW AREA	-1.7	-.3	-5.56	-3.89	-9.45	1	-.11	-148.00

#### ECO #1 - PIPE INSULATION

Savings are based upon replacing approximately 10% of the piping insulation that is in need of repair. It is assumed that damaged insulation provided no resistance to heat loss. This project has a payback period of approximately 6 years. Its SIR is 1.95.

#### ECO #3 - CAULK AND SEAL WINDOWS

Energy is wasted by air infiltrating through window cracks. The savings shown for this project are based upon estimates of crack width and length for all windows. This project shows considerable energy savings with a rapid payback of 4.94 years and a SIR of 1.37.

#### ECO #6 - WINDOW AREA REDUCTION

By reducing window area, summer cooling loads are decreased through a reduction in solar heat gains. If windows are replaced with materials having "U" values equal to those of the existing wall, then winter heating loads should also be reduced.

Savings for this ECO are estimated through computer simulation. The computer program shows there is no significant potential for conserving energy by reducing window area at the laundry facility.

#### ECO #7 - INSTALL GAS HW HEATER

Efficiency of hot water production is currently limited to the system efficiency of central plant equipment. The PVI Company produces a gas fired hot water heater that guarantees efficiencies in excess of 83%. The high efficiency is accomplished through direct contact heating elements and utilization of a stack economizer. The installation of such a heater will reduce energy consumption at the laundry facility by approximately 1367 MBTU per year and provide a payback period of less than 4 years.

#### ECO #8 - LIGHTING MODIFICATIONS

The laundry facility is currently lighted with standard suspended fluorescent light fixtures. There is only one 200 watt incandescent fixture in the building. Existing lighting efficiency can be improved by installing new ballasts and lamps and by reducing lighting levels in the accounting area.

ECO #8 will save approximately 54 MBTU of electrical energy. The payback period for this project is 11.34 years. The SIR is 0.77.

#### ECO #12 - INSTALL RADIANT HEATERS

Building heating efficiency can be improved by replacing existing steam unit heaters with infra-red radiant heaters. Infra-red heating provides comfort at reduced temperatures and eliminates the need for electrical energy.

ECO # 12 provides an estimated fuel savings of 360 MBTU and electricity savings of 7.86 MBTU each year. This project has a payback of 10.75 years and an SIR of 1.06.

#### ECO #14 - HEAT DESTRATIFICATION

This project involves installing circulating fans at ceiling level to force warm air back to floor level. The savings accomplished in fuel consumption are offset by additional electricity consumption.

#### ECO #15 & #15A - WASH WATER HR

This project involves the installation of a skid-mounted packaged heat recovery unit. The heat recovery unit directs waste water through a heat exchanger and heats incoming cold water. The unit also has the capacity to store hot water and provide additional heat as needed.

ECO #15 provides an annual fuel savings of 4375 MBTU under existing conditions. If this project is implemented along with a more efficient hot water heater (ECO #15A), the annual savings are 3954 MBTU and the payback period is 8.54 years with an SIR of 1.84.

#### ECO #17 - LOWER HOT WATER TEMPERATURES

This project involves adjusting hot water supply temperature at the central plant and using existing booster heaters to achieve temperatures required at each washer. This project saves 941 MBTU each year with a payback of .04 years. This project should be tested before overall implementation. The exact capacity of existing booster heaters is unknown and required temperatures may not be achieved at each washer. One unit should be selected for testing before this project is implemented.

#### ECO #19 - STEAM TRAP REPLACEMENT

The savings estimated through steam trap replacement are based upon leakage of one trap. No faulty traps were identified during the audit process. This ECO is presented to emphasize the importance of a steam trap inspection program.

#### ECO #20 - INSTALL 1000 LB CBW

This project involves the installation of a continuous batch washer with a total capacity of 1000 pounds. This type of equipment reduces energy consumption by reducing hot water consumption. This project gives a payback of 15.01 years and a SIR of 1.08.

#### ECO #20A - REPLACE STEAM DRYERS

Existing 100 lb steam dryers have extremely low efficiency due to equipment design and resulting long drying cycles. All of the steam dryers now in place (20) can be replaced with two each 220 lb gas fired dryers without a reduction in total capacity.

ECO #20A provides an annual fuel savings of 3123 MBTU. Annual electricity savings are estimated to be 2.8 MBTU. The simple payback period is 8.24 years and the SIR is 1.96.

#### ECO #20B - REPLACE 400 LB GAS DRYERS

Advanced technology and design has produced gas dryers that can remove 1 lb of water for as little as 1800 BTU's. Existing dryers use approximately 2700 BTU's to remove 1 lb of water.

This ECO has a simple payback of over 20 years and an SIR of 0.73.



#### ECO #21 - INSTALL AIR CURTAIN

Considerable quantities of outside air infiltrate into the building through the loading dock area. Reducing this infiltration will also reduce overall energy consumption.

ECO #21 involves installing a PVC closure type curtain rather than a forced air type curtain. This project saves approximately 393 MBTU each year and pays for itself within seven months. Since this is a low cost project with rapid payback it should be implemented as soon as possible.

#### ECO #23 - RECYCLE RINSE WATER

Energy can be conserved by recycling rinse water to following wash cycles. To accomplish water recycling diverting valves must be installed on existing washers. A collection sump, circulating pump and holding tank must be installed. Some control modifications are also required.

ECO #23 saves approximately 2479 MBTU of energy each year and a payback period of 4.03 years. Its SIR is 3.82.

#### ECO #24 - EXHAUST HEAT RECOVERY 100 LB DRYERS

Considerable energy is wasted from dryer exhaust air. The installation of an air to air heat exchanger will recover much of this wasted energy. Existing 100 lb dryers are exhausted through two separate lint filter systems. Heat exchangers could be installed at these two common points.

This ECO provides considerable energy savings potential. It is estimated that approximately 7678 MBTU of fuel could be saved each year through this project. However, high equipment costs cause this ECO to have a marginal payback of 16.38 years and an SIR of 1.00.

#### ECO #24A - EXHAUST HEAT RECOVERY 400 LB DRYERS

Existing 400 lb dryers are exhausted separately and each dryer would require it's own heat recovery unit. "Energenics" Inc. manufacturers a package heat recovery and lint filter system. Installation of these units shows an energy savings potential of 1273 MBTU per year. However, the payback period for this project (13.91 years) is marginal and it has an SIR of 1.16.

#### ECO #26 - THERMAL FLUID PRESSES

Thermal fluid presses provide improved efficiency and production over existing steam presses. ECO #26 involves replacing existing sheet presses with new thermal fluid presses.

This project provides an estimated savings of 1620 MBTU per year in fuel energy and 13.75 MBTU in electrical energy. The payback period is in excess of 40 years and its S1R is 0.42.

#### ECO #27 - COLD WATER LAUNDERING

Energy required for water heating can be eliminated through cold water laundering. However, wash cycle times will increase slightly and the quality of product is usually not as good as achieved through hot water laundering. Although, this ECO provides energy savings and rapid payback, careful consideration should be given to the quality of the end product prior to implementing this ECO.

#### ECO #31 - SHUT OFF STEAM

Energy can be conserved by shutting off boilers when there is no requirement for steam. This procedure will eliminate boiler cycling to maintain system pressure during off use periods. This ECO saves energy and has a rapid payback period. However, the periodic shut down of central plant boilers causes thermal expansion and contraction in the steam distribution system. Repeated cycles of expansion and contraction can result in pipe system failure.

## VIII RECOMMENDED ENERGY CONSERVATION OPPORTUNITIES (ECOS)

In the preliminary submittal of this report, 4 separate ECOS were recommended for implementation. Those recommended were as follows:

ECO #7	-	INSTALL GAS HW HEATER
ECO #8	-	LIGHTING MODIFICATIONS
ECO #15A	-	WASH WATER HR (With separate Heater)
ECO #20A	-	REPLACE STEAM DRYERS

The total combined energy savings from the above ECOS are approximately 7262 MBTU in fuel consumption and 57 MBTU in electricity use. The total annual dollar savings are approximately \$36,755. The total cost for implementing the above ECOS is approximately 239,000 dollars. The combined payback period equates to 6.48 years and the savings investment ratio (SIR) is 3.04. Programming documents for a project including the above ECOS was included as part of the preliminary submittal.

As part of this final report, the Director of Engineering and Housing (DEH) at Fort Leonard Wood was asked to list those ECOS which should be set aside for the development of funding documentation. The DEH indicated the following projects should have programming documents prepared as part of this study:

PROJECT #1	-	ECO #3 (Caulk and Seal Windows)
		ECO #17 (Lower Hot Water Temperatures)
		ECO #21 (Install Air Curtain)
PROJECT #2	-	ECO #20A (Replace Steam Dryers)
PROJECT #3	-	ECO #23 (Recycle Rinse Water)

Project #1 has a total construction cost of \$6,524 when overhead and design costs are included. This project results in energy savings of approximately 1632 MBTU of LPG gas use. The annual dollar savings are \$5337 and the savings investment ratio (SIR) equates to 15. The payback period is about 1.1 years.

Project #2 has a total construction cost of \$93,900 when overhead and design costs are included. This project results in energy savings of approximately 3123 MBTU of LPG gas use. The electricity savings is approximately 2.8 MBTU. The total annual dollar savings are \$10,255 and the savings investment ratio (SIR) equates to 1.96. The payback period is about 1.1 years.

Project #3 above has a total construction cost of \$36,377 when overhead and design costs are included. This project results in energy savings of approximately 2479 MBTU of LPG gas use. The annual dollar savings are \$8106 and the savings investment ratio (SIR) equates to 3.82. The payback period is about 4.0 years.

Project documents for the projects 1 through 3 are included in Section V of Volume II of this report.